Sri Chandrasekharendra Saraswathi Viswa MahaVidyalaya

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Department of Electronics and Communication Engineering

BE – ECE
First year syllabus
(2025 -2026)

"Your Journey to Knowledge Begins Here"

Syllabus (2025-26)

B.E. (Electronics and Communication Engineering)

CURRICULUM

Semester I

Sl.No	Course Code	Course Name	Category	Hours Per Week			Credits		IA	EA	TM
				L	T	P	Theory	Practical			
1.		English	AEC -1	2	0	0	2	-	40	60	100
2.		Mathematics –I	BSC	3	1	0	4	-	40	60	100
3.		Engineering Physics	BSC	3	0	2	3	1	40	60	100
4.		Universal Human Values.	VAC -1	2	0	0	2	-	100	-	100
5.		Environmental Science and Engineering	MC-1*	2	0	0	0	-	100	-	100
6.		Design Thinking	VSEC – 1	2	0	0	2	-	40	60	100
7.		IDEA workshop Lab	DIY – I	0	0	2	-	2	40	60	100
8.		NASSCOM/SWAYAM PLUS online course	MC – 2*	30Hrs			-	0	-	-	-
Total							**16**				

Semester II

Sl.No	Course Code	Course Name	Category	Hours per Week			Credits		IA	EA	TM
				L	T	P	Theory	Practical			
1.		Mathematics –II	BSC	3	1	0	4	-	40	60	100
2.		Engineering Chemistry	BSC	3	0	2	3	1	40	60	100
3.		Basic Electrical & Electronics Engineering	ESC	2	1	0	3	-	40	60	100
4.		Programming for Problem Solving	ESC	3	0	0	2	-	40	60	100
5.		Engineering Graphics and design[T&P]	ESC	2	0	1	3	-	40	60	100
6.		Basic Electrical & Electronics Engineering Lab	ESC	0	0	2	-	2	40	60	100
7.		Programming for Problem Solving Lab	ESC	0	0	2	-	2	40	60	100
8.		Soft skills	VSEC - 2	2	0	0	1	-	100	-	100
9.		Industrial visit /survey/Technical Seminar.	ELC	-	-	-	1	-	-	-	-
10.		NSS/Technical club/Green cell/ Archaeological Site Visit and survey	CEA	-	-	-	1	-	-	-	-
11.		NASSCOM/SWAYAM PLUS online course	MC -3*	30Hrs			0	-	-	-	-
Total							**24**				

Total Credits (in first Year): 40 Credits

[**L** -Lecture, **T**- Theory, **P**-Practical, **C**-Credit, **IA**- Internal Assessment, **EA**- External Assessment, **TM**-Total Mark, * **Not calculated for CGPA**]

SEMESTER - I

Course Code		**L**	**T**	**P**	**C**	**IA**	**EA**	**TM**
Course Name	**ENGLISH**	2	0	0	2	40	60	100
Course Category	ABILITY ENHANCEMENT COURSE/ HUMANITIES/SOCIAL SCIENCE/ MANAGEMENT COURSE	**Syllabus Revision**					V.1.0	
Pre-requisite								

Course Objectives:

The course should enable the students:

1. To enhance proficiency in English language skills.
2. To develop ability to think analytically, speculatively and imaginatively.
3. To see themselves as professionals, as part of a discipline with skills and abilities valuable in business, teaching, publishing, etc.

Course Outcomes:

On completion of the course, the student will be able to:

Course Outcomes	**Description**	**Highest Bloom's Taxonomy**
CO1	Understand the nuances of grammar and vocabulary in speaking and writing	**K2**
CO2	Listen and comprehend different spoken excerpts critically, infer and implied meanings.	**K1**
CO3	Speak convincingly, express their opinions clearly, initiate a discussion, negotiate, and argue using appropriate communicative strategies.	**K4**
CO4	Read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for Method of presentation.	**K2**
CO5	Write effectively and persuasively and by using different techniques of writing such as narration, description, exposition and argument as well as creative, critical, analytical and Evaluative writing.	**K4**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	-	-	-	-	M	L	L	L	M	M	L	M	-	-	-

CO2	-	-	-	-	M	L	L	L	L	L	L	M	-	-	-
CO3	-	-	-	-	L	L	L	L	L	L	L	L	-	-	-
CO4	-	-	-	-	L	L	L	L	L	L	L	L	-	-	-
CO5	-	-	-	-	M	L	L	L	M	M	L	M	-	-	-

UNIT-I	**VOCABULARY BUILDING**	**9 Hours**

The concept of Word Formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form Derivatives - Synonyms, antonyms, and standard abbreviations.

UNIT-II	**BASIC WRITING SKILLS**	**9 Hours**

Sentence Structures - Use of phrases and clauses in sentences - Importance of proper punctuation - Creating coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely.

UNIT-III	**IDENTIFYING COMMON ERRORS IN WRITING**	**9 Hours**

Subject-verb agreement - Noun pronoun agreement - Misplaced modifiers - Articles - Prepositions - Redundancies – Clichés.

UNIT-IV	**NATURE AND STYLE OF SENSIBLE WRITING**	**9 Hours**

Describing – Defining – Classifying - Providing examples or evidence -Writing introduction and conclusion.

UNIT-V	**WRITING PRACTICES**	**9 Hours**

Comprehension - Précis Writing - Essay Writing.

UNIT-VI	**ORAL COMMUNICATION**	

(This involves interactive practice sessions in Language Lab)
Listening Comprehension - Pronunciation, Intonation, Stress and Rhythm - Common Everyday situations: Conversations and Dialogues - Communication at Workplace – Interviews - Formal Presentations

	Total Hours	**45 Hours**

Text Book(s)

1.	Practical English Usage. MichaelSwan.OUP. 4th edition.
2.	Remedial English Grammar. F.T.Wood.Macmillan.Jan-2014.
3.	On Writing Well William Zinsser. Harper Resource e Book.9th May 2006.

Reference Book(s)

1.	Study Writing, Liz Hamp – Lyons and Ben Heasly, Cambridge University Press, 2nd edition, 31st Jan2007.
2.	Communication Skills, Sanjay Kumar and Pushpa Lata, Oxford University Press, 2nd Edition, 2015.

Course Code		**L**	**T**	**P**	**C**	**IA**	**EA**	**TM**
Course Name	**MATHEMATICS -I**	3	1	0	4	40	60	100
Course Category	BASIC SCIENCE COURSE	**Syllabus Revision**					V.1.0	
Pre-requisite								

Course Objectives:
The course should enable the students -

1. To understand matrix theory, including eigenvalues, eigenvectors, and quadratic forms, for solving engineering problems.
2. To apply numerical methods for solving algebraic and transcendental equations using both direct and iterative techniques.
3. To learn interpolation, numerical differentiation, and integration methods for approximating functions and values.
4. To evaluate multiple integrals and use Beta and Gamma functions in engineering applications.
5. To apply vector calculus concepts and theorems to solve problems in physics and engineering fields.

Course Outcomes:
On completion of the course, the student will be able to

Course Outcomes	**Description**	**Highest Bloom's Taxonomy**
CO1	Solve problems involving eigenvalues, eigenvectors, and reduce matrices and quadratic forms to canonical forms.	**K3**
CO2	Apply numerical methods to find approximate solutions of algebraic and transcendental equations.	**K5**
CO3	Use interpolation techniques and numerical integration/differentiation for estimating values from data.	**K5**
CO4	Evaluate double and triple integrals, and apply Beta and Gamma functions in engineering contexts.	**K5**
CO5	Compute gradient, divergence, and curl, and apply vector integral theorems in physical applications.	**K3**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	S	S	S	S	S	-	M	-	-	M	M	M	-	-	-
CO2	S	S	S	S	S	-	-	-	M	M	L	M	-	-	-
CO3	S	S	S	S	S	-	M	-	L	M	L	M	-	-	-

CO4	S	S	S	S	S	-	M	L	M	M	M	M	-	-	-
CO5	S	S	S	S	S	-	L	-	L	M	L	M	-	-	-

UNIT-I	Matrices	**12 Hrs**

Eigen Value and Eigen Vectors – Properties of Eigen Values – Cayley-Hamilton Theorem – Reduction to Diagonal Form – Reduction of Quadratic Form to Canonical Form – Nature of Quadratic Forms.

UNIT-II	Numerical Solutions to Algebraic Equations	**12 Hrs**

Introduction – Solution of Algebraic and Transcendental Equations – Bisection Method, Method of False Position, Newton's Method – Solution of Linear Simultaneous Equations – Direct Methods of Solution – Gauss Elimination, Gauss-Jordan Method – Indirect Methods of Solution –Jacobi's Method, Gauss-Seidel Method.

UNIT-III	Interpolation, Numerical Differentiation and Integration	**12 Hrs**

Finite Differences – Newton's Interpolation Formula – Interpolation with Unequal Intervals – Lagrange's Formula – Divided Differences – Newton's Divided Difference Formula. Numerical Differentiation – Formulae for Derivatives – Numerical Integration – Newton-Cote's Quadrature Formula – Trapezoidal Rule – Simpson's $1/3^{rd}$ Rule – Simpson's $3/8^{th}$ Rule.

UNIT-IV	Multiple Integrals and Beta-Gamma Functions	**12 Hrs**

Double Integrals – Change of Order of Integration – Double Integrals in Polar Coordinates – Area enclosed by Plane Curves – Triple Integrals – Volume of Solids – Beta Function – Gamma Function – Relation between Beta Function and Gamma Function.

UNIT-V	Vector Calculus	**12 Hrs**

Scalar and Vector Point Functions-Vector Operator del. – Del applied to Scalar Point Functions-Gradient – Del applied to Vector Point Functions-Divergence and Curl – Del applied twice to Point Functions – Del applied to Product of Point Functions – Integration of Vectors – Line Integrals-Circulation-Work – Surface Integral-Flux – Green's Theorem in the Plane – Stoke's Theorem – Volume Integral – Divergence Theorem – Irrotational and Solenoidal Fields.(statement only for theorems)

Total Hours	**60 Hrs**

Text Book(s)

1.	B.S. Grewal, Higher Engineering Mathematics, 42^{nd} Edition, Khanna Publishers.

Reference Book(s)

1.	1. Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition.

Course Code		L	T	P	C	IA	E A	TM
Course Name	ENGINEERING PHYSICS	3	0	2	4	40	60	100
Course Category	BASIC SCIENCE COURSE	Syllabus Revision					V.1.0	
Pre-requisite								

Course Objectives:
The course should enable the students -

1. Theory of Interference-Newton strings, Michelson Interferometer and Fresnel and Fraunhoffer diffraction, Diffraction due to "n" slits - Plane Transmission grating.
2. Energy distribution in black body - Planck's law, De Broglie matter waves – dual nature and expression, Schrodinger Time Independent and Dependent, wave equation, Expression for particle in1-D box and applications.
3. Laser - Principles and Properties, Einstein's theory, Types of lasers – Nd: YAG and CO2 laser Applications of lasers – IR Thermograph, Optical fibers-Types of optical fibers, Acceptance angle and numerical aperture, Fiber losses, Applications in engineering and medicine.
4. PN Junction diode and Zener diode - V-I characteristics, BJT, SCR, FET, D-MOSFET, E-MOSFETCharacteristics, Characteristics of CMOS, Logic Gates and Universal Building Blocks.
5. Fundamentals of dielectric materials, Internal field and Clausius - Mossotti relation, Super conductors–properties and types - BCS theory, Nano materials – Synthesis, Ball milling and PVD method. Principle and properties of SMA and Biomaterials.

Course Outcomes:
On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	To develop an understanding of the principles of optics.	K2
CO2	Experience the diverse applications of the wave equation. Learn the mathematical tools needed to solve quantum Mechanics problems.	K4
CO3	To provide adequate knowledge on laser fundamentals types and applications and to expose the basics of signal propagation through fiber optics	K2
CO4	Understand the principles and concepts of semiconductor Physics. Understand and utilize the mathematical models of Semi conductor junctions and MOS transistors for circuits and systems.	K2
CO5	Acquire basic knowledge on various newly developed smart materials.	K2

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PSO2	PSO3

	1	2	3	4	5	6	7	8	9	10	11	12	O1		
CO1	S	S	M	M	M	L	M	L	M	M	L	L	-	-	-
CO2	S	S	S	S	S	M	M	L	M	M	L	L	-	-	-
CO3	S	S	S	S	S	M	M	M	M	S	S	S	-	-	-
CO4	S	S	S	S	S	L	L	L	M	M	M	M	-	-	-
CO5	M	M	M	M	M	S	S	M	M	M	M	M	-	-	-

UNIT-I	QUANTUM PHYSICS	9 Hours

Black body radiation-Planck's law – Energy distribution function, Wave – particle duality-de Broglie matter waves – Concept of wave function and its physical significance – Heisenberg's Uncertainty Principle – Schrodinger's wave equation – Time independent and Time dependent equations– Tunneling -Scanning tunneling microscope.

UNIT-II	LASER PHYSICS	9 Hours

Einstein's theory of matter - radiation interaction and A and B coefficients; Properties of laser-spontaneous and stimulated emission, amplification of light by population inversion, different types of lasers: solid-state laser(Nd:YAG), gas lasers (CO2), applications –IR Thermography

UNIT-III	FIBRE OPTICS.	9 Hours

Optical fiber- structure – core and cladding - principle [TIR] - types- material, mode, refractive index profile -Fiber losses -Expression for acceptance angle and numerical aperture. Applications- Endoscope and optical fiber Communication.

UNIT-IV	SEMICONDUCTOR DEVICES AND APPLICATIONS	9 Hours

Introduction to P-N junction Diode and V-I characteristics, Zener diode and its characteristics, Introduction to BJT, its input-output and transfer characteristics, SCR characteristics, FET, MOSFET and CMOS characteristics. Basic logic gates - NAND, NOR as Universal building block.

UNIT-V	NEW ENGINEERING MATERIALS	9 Hours

Dielectric materials: Definition – Dielectric Breakdown – Dielectric loss – Internal field – Claussius Mossottirelation. Superconducting materials: Introduction – Properties- Meissner effect – Type I & Type II superconductors – BCStheory-Applications.Na nomaterials: Introduction – Synthesis of nano materials – Top down and Bottom up approach- Ball milling- PVD method- Applications. Smart materials: Shape memory alloys- Biomaterials (properties and applications).

LIST OF EXPERIMENTS FOR LABORATORY COURSE [Any 8]

[1]. Determination of Rigidity Modulus & Moment of Inertia using Torsional Pendulum.
[2]. Determination of Young's Modulus.

[3]. Determination of Wavelength of Laser light using transmission grating.
[4]. Determination of particle size using LASER
[5]. Measurement of numerical aperture of an optical fiber.
[6]. Determination of wavelength of light using Newton's Rings apparatus.
[7]. Determination of Velocity of sound waves in liquid using Ultrasonic interferometer.
[8]. Determination of wavelength of prominent colors of mercury spectrum using grating.
[9]. Determination of number of lines per meter of the grating using normal incidence method.
[10]. Determination of refractive index of the given prism using minimum deviation method.
[11]. Determination of emissivity of the surface of a black body.
[12]. Basic logic gates- Verification of truth tables
[13]. NAND-Universal building block
[14]. NOR-Universal building block
[15]. Zener diode- I-V characteristics
[16]. Study of LCR circuit

Total Hours	**45 Hours**

Text Book(s)

1.	Sathyaprakash, "Quantum Mechanics", Pragati Prakashan, 2016 [unit I]
2.	K.Venkatramanan, R.Raja, M.Sundarrajan, "Applied Physics for Engineers", SciTech, 2014 [units II,III,V]
3.	V.K.Mehta, "Principles of Electronics", S Chand & Co, 2014 [unit –IV]

Reference Book(s)

1.	V. Devanathan, "Quantum Mechanics", Narosa, 2011
2.	M.N. Avadhanulu, "Engineering Physics", S Chand & Co, 2007
3.	B L Theraja, "Basic Electronics (Solid State)", S Chand & Co, 2005
4.	D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", Wiley, 2001
5.	Arthur Beiser, Shobhit Mahajan, "Concepts of Modern Physics", McGraw Hill Education, 2009

Course Code		L	T	P	C	IA	EA	TM
Course Name	**UNIVERSAL HUMAN VALUES**	2	0	0	2	40	60	100
Course Category	VALUE ADDED COURSE	**Syllabus Revision**					V.1.0	
Pre-requisite	Nil							

Course Objectives:

The course should enable the students -

1. To appreciate the complementarities between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings
2. To facilitate the development of a Holistic perspective among students towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence.
3. To highlight Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.
4. This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Become more responsible in life and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.	**K2**
CO2	Have better critical ability.	**K2**
CO3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).	**K2**
CO4	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.	**K3**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	-	-	-	S	M	L	L	M	L	L	L	L	L
CO2	-	-	-	-	-	-	-	M	-	-	M	S	L	M	L
CO3	-	-	-	-	-	S	S	M	M	S	M	L	L	L	M
CO4	-	-	-	-	-	L	M	L	S	M	L	L	L	M	M

UNIT-I	INTRODUCTION TO VALUE EDUCATION	9 Hours

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations.

UNIT-II	HARMONY IN THE HUMAN BEING	9 Hours

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

UNIT-III	HARMONY IN THE FAMILY AND SOCIETY	9 Hours

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

UNIT-IV	HARMONY IN THE NATURE/EXISTENCE	9 Hours

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, Holistic Perception of Harmony in Existence.

UNIT-V	IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS	9 Hours

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Total Hours	**45 Hours**

Text Book(s)

1.	The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 97893-87034- 47-1.
2.	The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Book(s)

1.	Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	The Story of Stuff (Book).
4.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5.	Small is Beautiful - E. F Schumacher
6.	Slow is Beautiful - Cecile Andrews

7.	Economy of Permanence - J C Kumarappa
8.	Bharat Mein Angreji Raj – Pandit Sunderlal
9.	Rediscovering India - by Dharampal
10.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11.	India Wins Freedom - Maulana Abdul Kalam Azad
12.	Vivekananda - Romain Rolland (English)
13.	Gandhi - Romain Rolland (English)
14.	Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15.	Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
16.	A Nagraj, 1998, JeevanVidya EkParichay, Divya Path Sansthan, Amarkantak.
17.	P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18.	A N Tripathy, 2003, Human Values, New Age International Publishers.
19.	Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantra Shodh, Amravati.
20.	E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
21.	M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22.	B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23.	B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Course Code		L	T	P	C	IA	EA	TM
Course Name	ENVIRONMENT SCIENCE AND ENGINEERING	2	0	0	0	40	60	100
Course Category	MANDATORY COURSE (MC)*	Syllabus Revision				V.1.0		
Pre-requisite								

Course Objectives:

The course should enable the students

1. To study the nature and facts about environment.
2. To finding and implementing scientific, technological, economic and political solutions to environmental problems.
3. To study the inter relationship between living organism and environment.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Nature of environment and reasons for environmental problems.	K4
CO2	Ecosystem – structure, functions, simplified co-system models.	K6
CO3	Natural resources, reasons for over exploitation of resources.	K2
CO4	The interrelationship between living organism and environment.	K4
CO5	Public awareness of environmental is at infant stage.	K2

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O2	PS O3
CO1	L	L	L	L	-	M	M	S	M	M	M	L	-	-	-
CO2	M	M	M	M	L	M	M	S	M	M	M	L	-	-	-
CO3	-	-	-	-	M	M	M	S	M	M	M	L	-	-	-
CO4	L	L	L	L	M	M	M	S	M	M	M	L	-	-	-
CO5	L	L	L	L	M	M	M	S	M	M	M	L	-	-	-

UNIT-I	INTRODUCTION TO ENVIRONMENT AND ENVIRONMENTAL STUDIES	9 Hours

1.1. Introduction to environment – components – nature of environment – need of awareness– reasons for environmental problems – anthropocentric and eco centric views. 1.2. Environmental

studies - multidisciplinary nature – scope and aim – sustainable development principles – RRR concept-Indian environmental movements–environmental calendar.

UNIT-II	ECO SYSTEM AND BIO DIVERSITY	9 Hours

2.1. Ecosystem – structure – functions – simplified ecosystem models (food chain and food webs and their types, energy flow) - forest – grassland – pond –ecosystems – ecological succession – ecological pyramids–Bio-geo chemical cycles of water–oxygen-carbon-phosphorous and sulphur. 2.2.Biodiversity – definition – types – species – genetic and ecosystem diversities-values of biodiversity – threats to biodiversity – conservation of biodiversity – endemism – biodiversity hotspots – Indian biodiversity– endemic species of India–IUCN lists – red – green and blue data books.

UNIT-III	NATURAL RESOURCES	9 Hours

3.1 Natural resources – definition – types – forest resources – uses –deforestation- reasons - effects – water resources – dams – effects of dams - food resources – modern agriculture– ill effects – energy resources -types–hydel–nuclear–solar–wind and biomass energy-world scenario–Indian scenario. 3.2 Population and environment–reasons for over exploitation of resources–population– demography – population curves – population explosion – effects – consumerism – effects – urbanization – reasons and effects – role of an individual.

UNIT-IV	ENVIRONMENT POLLUTION	9 Hours

4.1 Pollution–definition–types–air pollution –causes and effects–effects of CO2–CO – NOx – SOx – particulates–control of air pollution–water pollution–causes–effects–remedies–soil pollution– solid waste management – e-waste – ill effects of e-waste – proper recycling – Noise pollution – reasons–effects – control – nuclear pollution – cases – effects and control –thermal pollution causes – effects and remedies. 4.2 Legal provisions for protecting environment – article 48 A – 51 A (g) – Environment act1986 – Air act 1981 – Water act 1974 – wild life protection act – Forest act 1980 - problems in implementation–reasons.

UNIT-V	SOCIAL ISSUES AND ENVIRONMENTAL ETHICS	9 Hours

Present environmental scenario – green house effect – climate change–The Kyoto Protocol–ozone layer depletion- The Montreal Protocol-acid rain–causes–effects-disparity among the nations– The Copenhagen UNFCCC summit – carbon currency- virtual water- genetically modified organisms, Disaster management. 5.2 Environmental ethics–introduction–people getting affected- resettlement and rehabilitation – issues involved –Sardhar Sarovar project – Tawa Matsya sang - Melting icebergs of Arctic.

	Total Hours	45 Hours

Text Book(s)

1. Anubha Kaushik and C.P. Kaushik,"Prospects of Environmental Science", New Age International publishers, 2019.

Reference Book(s)	
1.	Environmental Studies, N.Nandini, N. Sunitha and SucharitaTandon, Sapna Book House, 2019.
2.	Text book of Environmental Science, Ragavan Nambiar, Scitech Publications, 2010.
3.	Text book of Environmental Chemistry and Pollution Control, S.S.Dara, S.Chandand Co., 7th Edition.
4.	Environmental Chemistry, Colin Baird, W.H.Freemanand company, NewYork, 4th Edition, 2008.
5.	Environmental Chemistry, Gary W.VanLoon and StephenJ. Duffy, Oxford University Press, 9th Edition 2017.
6.	New Trends in Green Chemistry, V.K. Ahluwalia and M. Kidwai, Anamaya Publishers, 1st Edition 2012.

Course Code		L	T	P	C	IA	EA	TM
Course Name	**DESIGN THINKING**	2	0	0	2	40	60	100
Course Category	VOCATIONAL AND SKILL ENHANCEMENT COURSE **-1**	**Syllabus Revision**					V.1.0	
Pre-requisite								

Course Objectives:

1. To understand various learning process, understanding the problems and enhancement techniques on innovative engineering products.
2. To understand the importance of the design thinking tools.
3. To learn about the problem-solving techniques and gain the knowledge about Empathy methods.
4. To develop skills in ideation, product design tools and prototyping.
5. To develop skills in testing, innovations, and collaboration on novel products.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Classify the various learning principles and styles, memory technologies, and assess the emotional experience when examining emotional expressions in engineering education in order to create novel products.	**K2**
CO2	Discover the importance of brainstorming and how to apply design thinking tools to produce new products through innovative thinking.	**K3**
CO3	Propose the suitable problem-solving techniques through different Empathy tools and methods on defining problem statement on new products.	**K3**
CO4	Generate new ideation techniques applied on new product design and evaluate prototype effectiveness on different suitable developed prototype models.	**K3**
CO5	Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.	**K3**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO3**
CO1	M	L	L	L	-	-	-	-	-	-	-	-	-	-	-

CO2	M	M	L	L	-	-	-	-	-	-	-	-	-	L	M
CO3	L	M	M	M	L	L	-	-	-	-	-	-	L	M	M
CO4	M	M	M	S	M	L	L	L	M	L	M	M	L	M	L
CO5	M	M	M	M	-	M	-	L	M	M	-	M	L	L	M

UNIT-I	**BASICS OF LEARNING, UNDERSTANDING AND ENHANCEMENT TECHINIQUES**	**9 Hours**

An Insight to Learning Process –Principles and Dimensions of Learning Process – Understanding the Problems– Learning Styles– Human Centered Design –Assessing and Interpreting– Remembering and Understanding the Memory process–Problems in Learning Retention process – Memory Enhancement Techniques –Emotions and Psychology –Applications of Peer Learning– Examples.

UNIT-II	**DESIGN THINKING TOOLS**	**9 Hours**

Design Thinking process – Definition and Need of Design Thinking –Objectives and Features of Design Thinking–Concept of Brainstorming– Design Thinking Frameworks –Design Thinking Mindsets – Design Thinking Tools– Empathize, Define, Ideate, Prototype and Test–Applications of Design thinking.

UNIT-III	**PROBLEM-SOLVING TECHNIQUES AND EMPATHYMAPPING**	**9 Hours**

Ingenious & Problem-Solving Understanding – Problem Solving & techniques – Role of Empathy – Methods and tools of Empathy – Defining the problem – Analysis and Synthesis – Empathy Mapping& its types – Customer journey mapping – Jobs-to-be-done concept– Point of View on Problem Statement.

UNIT-IV	**IDEATION, PRODUCT DESIGN AND PROTOTYPING**	**9 Hours**

Ideation methods – Principles of creativity & its methods–Brains torming techniques – Product design process –Process of Engineering Product design – Stages of Product design – Conceptual design – Examples of best product designs and functions – Assignment on Engineering Product Design – Prototype – Need of Prototype – Types of Prototype – Rapid Prototyping – Benefits of Prototyping.

UNIT-V	**TESTING, INNOVATION AND COLLABORATION**	**9 Hours**

Testing – Purpose of testing – Types of testing – Sample Examples – Test Group Marketing – Creative thinking process – Innovation – Needs of Innovation –Types of innovation – Characteristics of Innovation – Collaboration – Process, tools and techniques of collaboration – Importance of Collaborative design – steps involved in collaborative design– Benefits, challenges and applications of collaboration –Feedback – Re-Design & Re-Create Feedback loop.

	Total Hours	**45 Hours**

Text Book(s)

1. Idris Mootee, Design thinking for strategic innovation, Wiley publications, 2013.

2.	Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011.
3.	Michael Lewrick, Patrick Link, and Larry Leifer, The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, 2018, John Wiley & Sons.
Reference Book(s)	
1.	Balaguruswamy, E., "Developing Thinking Skills (The Way to Success)", Khanna Publisher, First Edition, January 2022.
2.	Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency/Doubleday, 2001
3.	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd, 2009
4.	Ulrich & Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004.
5.	Kevin Otto, Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson publications, 2001.

Course Code		**L**	**T**	**P**	**C**	**IA**	**EA**	**TM**
Course Name	IDEA LAB WORKSHOP	0	0	2	2	40	60	100
Course Category	DO IT YOURSELF	**Syllabus Revision**					V.1.0	
Pre-requisite								

Course Objectives:

The course should enable the students -

1. To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
2. Learn useful mechanical and electrical and electronic fabrication processes.
3. Learn necessary skills to build useful and standalone system/ project with enclosures.
4. Learn necessary skills to create print and electronic documentation for the system/ project.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	**Description**	**Highest Bloom's Taxonomy**
CO1	Acquire knowledge in utilizing various tools, devices and machines used in engineering practice.	**K3**
CO2	Understand different measuring instruments and safety standards	**K3**
CO3	Analyze various operations in mechanical engineering workshop	**K3**
CO4	Understand electronic system design flow, fabrication and testing of the circuits.	**K3**
CO5	Apply mechanical, electrical, and electronic fabrication processes to develop different prototypes	**K4**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO3**
CO1	L	L	-	-	L	-	-	-	-	-	-	-	L	M	-
CO2	L	-	-	-	M	-	-	-	-	-	-	-	L	L	-
CO3	L	M	M	L	M	-	-	-	-	-	-	-	L	L	L
CO4	L		M	M	S	-	-	-	-	-	M	-	M	M	L
CO5	L	L	M		S	-	-	-	M	-	S	-	M	M	M

Course Content Mechanical Engineering

Introduction to basic hand tools: Tape measure, combination square, Vernier caliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives
Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits.
3D printing and prototyping technology: 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering.
Course Content ECE/EEE
Familiarization and use of basic measurement instruments: DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output).
Electrical Measurements: use of multimeters- tong testers- continuity testing-use of contactors-push button switches-relays-fuses - electrical cabling tools-optical cable connectors.
Electronic component familiarization: Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub.
Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.
Electronic circuit building blocks including common sensors: Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging.

List of Lab activities and experiments (Department of Mechanical Engineering)	
1.	External thread cutting of bolts.
2.	Counter profile turning of wood using wooden lathe.
3.	Conversion of square prism to cylinder using bosch router.
4.	Cutting of square profile using 2D profile cutting machine.
5.	Cutting of Hexogon profile using 2D profile cutting machine.
6.	Fabrication practice of Safety grill for window using welding technique.
7.	Fabrication practice of joining two similar metals using TIG Welding.
8.	Printing of Cube using 3D printer.
9.	Printing of Cylinder using 3D printer.
List of Lab activities and experiments (Department of Electronics & Communication Engineering)	
1.	Familiarization of Active and Passive components, Resistorcolor coding, Different types of capacitor, Bread boardconnection, CRO and Function Generator, Schematic design andPCB layout and Gerber creation using KICAD, Tinker CAD andDifferent sensors.
2.	Schematic and PCB Design Layout of Analog Electronic circuits using KICAD Tool. 1. Simple LED 2. Voltage Regulator 3. Power supply 4. Inverting Amplifier

3.	Schematic and PCB Design Layout of Different sensor modulesusing KICAD Tool. 1. Voltage Sensors (LDR) 2. Proximity sensor 3. IR sensor
4.	(i). Interfacing a IR sensor with Arduino microcontroller. (ii). Interfacing a Relay shield with Arduino microcontroller. (iii). Interfacing a GSM (Global System for Mobile Communications) module with Arduino microcontroller
5.	Familiarization of Raspberry PI and perform Necessary SoftwareInstallation.
6.	Mini Project.
List of Lab activities and experiments (Department of Electrical & Electronics Engineering)	
1.	Study of cathode ray oscilloscope/digital storage oscilloscope.
2.	Study of Multimeter.
3.	Study of characteristics of the solar panel.
4.	Study of Characteristic regulated power supply.
5.	Measurement of ac power using clamp meter.
REFERENCE BOOKS:	
1.	**AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with LabManual), ISBN: 978-9391505332**
2.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3.	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5.	The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6.	The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978- 1681881584.
7.	Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8.	The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9.	Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10.	Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 978-9352133703
11.	Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12.	Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13.	Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13 : 978-1260019193.
14.	Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773
15.	Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies,

	Kluwer, 2004.
16.	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17.	Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

SEMESTER - II

Course Code		L	T	P	C	IA	EA	TM
Course Name	**MATHEMATICS -II**	3	1	0	4	40	60	100
Course Category	BASIC SCIENCE COURSE	**Syllabus Revision**				V.1.0		
Pre-requisite								

Course Objectives:

The course should enable the students -

1. To equip students with techniques to solve ordinary differential equations using analytical and numerical methods.
2. To develop an understanding of partial differential equations and methods of finding their general and particular solutions.
3. To introduce Fourier series and their applications in representing periodic functions.
4. To familiarize students with Laplace transforms and their use in solving differential equations.
5. To provide a foundation in Fourier transforms and their properties for analyzing signals and systems.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Solve ordinary differential equations using analytical methods and numerical techniques such as Taylor's series, Runge-Kutta, and Milne's methods.	**K6**
CO2	Formulate and solve partial differential equations using appropriate methods including Charpit's method.	**K6**
CO3	Represent periodic functions using Fourier series and apply them to solve engineering problems.	**K6**
CO4	Apply Laplace transforms and their properties to solve differential equations and evaluate integrals.	**K6**
CO5	Use Fourier transforms to analyze signals and solve problems involving integral transforms.	**K6**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-
CO2	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-
CO3	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-

CO4	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-
CO5	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-

UNIT-I	Differential Equations	12 Hours

Method of variation of parameters - Equations reducible to linear equations with constant coefficients: Cauchy's homogeneous linear equation- solving of Ordinary differential equations using Numerical methods: Taylor's series, Runge-Kutta method of fourth order for solving first order equations - Milne's predicator corrector methods.

UNIT-II	Partial Differential Equations	12 Hours

Formation of partial differential equations – Solution of a partial differential equation – Equations solvable by direct integration – Linear equations of first order – Non linear equations of the first order – Charpit's method - Homogeneous linear equations with constant coefficients –Rules for finding complementary functions – Rules for finding particular integral – Solution of homogeneous linear equation of any order.

UNIT-III	Fourier series	12 Hours

Introduction- Euler's Formulae- Conditions for a Fourier expansion - Functions having points of discontinuity - Change of interval - Odd and even function-Expansions of odd or even periodic functions - Half-range series - Typical wave-forms - Parseval's formula.

UNIT-IV	Laplace Transforms	12 Hours

Definition, Properties of Laplace transforms: Linearity Property, First shifting property, Change of scale property – Transforms of derivatives - Transforms of integrals - Multiplication by t^n - Division by t - Evaluation of integrals by Laplace transform - Inverse transforms: Method of partial fractions – Other methods of finding inverse - Convolution theorem (without proof) Application to differential equations

UNIT-V	Fourier Transforms	12 Hours

Fourier integral theorem (without proof) - Fourier Sine and Cosine integrals – Complex form of Fourier integral - Fourier transform – Fourier sine and Cosine transforms – Properties of Fourier Transforms: Linear property, Change of scale property, Shifting property -Parseval's identity for Fourier transforms (without proof)

Total Hours | **60 Hours**

Text Book(s)

1.	B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers.

Reference Book(s)

1	Coddington, E. A, An Introduction to Ordinary Differential Equations. United Kingdom: Dover Publication. (2012).
2	Simmons, G. F. Differential Equations: With Applications and Historical Notes. India: Tata McGraw-Hill. (2003)
3	John, F. Partial Differential Equations. Germany: Springer New York(2013)
4	Evans, L. C. Partial Differential Equations. United States: American Mathematical Society(2022)

Course Code		L	T	P	C	IA	EA	TM
Course Name	ENGINEERING CHEMISTRY	3	0	2	4	40	60	100
Course Category	BASIC SCIENCE COURSE	Syllabus Revision					V.1.0	
Pre-requisite								

Course Objectives:

The course should enable the students

1. To learn the basics of atomic structure, bonding and analytical methods
2. To learn various types ofreactions in organic chemistry

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Analyze microscopic chemistry in terms of atomic and molecular orbital's andintermolecular forces.	K2
CO2	Rationalize bulk properties and processes using thermodynamic considerations.	K4
CO3	Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.	K2
CO4	Rationalize periodic properties.	K4
CO5	List major chemical reactions that are used in the synthesis of various organic molecules.	K4

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O2	PS O3
CO1	S	S	M	M	L	M	M	-	M	M	M	M	-	-	-
CO2	S	S	M	M	L	M	M	-	M	M	M	M	-	-	-
CO3	S	S	M	M	M	M	M	-	M	M	M	M	-	-	-
CO4	S	S	M	M	M	M	M	-	M	M	M	M	-	-	-
CO5	S	S	M	M	L	M	M	-	M	M	M	M	-	-	-

UNIT-I	Molecular Engineering and Nanotechnology	9 Hours

Review of chemical bonding - MO theory – formation of H2,He2,O2,N2,CO and HF – hybridization definition- CH4,C2H4 and C2H2 - Supramolecular chemistry definition – types of molecular assemblies - molecular machines (concepts only) – Nanomaterials-differences between bulk and nanophases -

synthesis (top-down and bottom-up) - Applications: sensors, energy devices, coatings .

UNIT-II	Engineering Materials – Polymers, Ceramics & Composites	9 Hours

Polymers – introduction – types - advanced functional polymers -conducting polymers - biodegradable plastics – PLA and cellulose derivatives - Engineering ceramics – properties – types – oxide (Alumina and zirconia) non-oxide (SiC) and composite ceramics (metal cements) - applications - Composite materials: classification and uses.

UNIT-III	Electrochemistry and Corrosion Control	9 Hours

Electrodes – types of electrodes – SEP – Nernst equation -Electrochemical cells, EMF, Nernst equation for cells -Batteries- Ni-Cd and Li-ion batteries - supercapacitors – introduction only - fuel cells introduction and types - Corrosion: types of corrosion - mechanisms, protection strategies.

UNIT-IV	Water treatment technology	9 Hours

Water as universal solvent – hardness-types - units of hardness -estimation of hardness - disadvantages of hard water – scale and sludges – water softening methods - ion exchange method, RO methods - Wastewater treatment: primary to tertiary methods - water pollutants types- heavy metals, microplastics and pesticide residues – effects. Domestic water treatment.

UNIT-V	Introduction to Green Chemistry	9 Hours

Introduction to Green Chemistry – definition, scope, and significance - Twelve Principles of Green Chemistry – Atom Economy – definition, calculation, and applications, Carbon Footprint and Water Footprint – concepts and relevance in chemical industries -LCA – introduction- imporatnace- Green Synthetic Methodologies – use of green solvents, supercritical fluids, and ionic liquids - SolventFree Reactions – techniques and advantages - Microwave-Assisted and Sonochemical Reactions – principles, mechanisms, and applications

LIST OF EXPERIMENTS FOR LABORATORY COURSE [Any 8]

1. Kinetics of Green synthesis of silver nanoparticles -Colorimetry
2. Determination of hardness of water (EDTA method)
3. Estimation of DO of water samples
4. Estimation of COD of water samples
5. Verification of Nernst equation for an electrode
6. Electrochemical cell construction and EMF measurement
7. Corrosion studies of metals
8. Prediction of Feasibility of cells
9. Bioplastic preparation and testing
10. Ion exchange water purification
11. Green synthesis of bis-naphthol
12. Air particulate analysis using filter method

	Total Hours	45 Hours

Text Book(s)

1.	Jain & Jain, Engineering Chemistry, Dhanpat Rai Publishing, Latest Edition.
Reference Book(s)	
1.	P.C. Jain & Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing.
2.	Shashi Chawla, A Textbook of Engineering Chemistry, Dhanpat Rai & Co.
3.	S.S. Dara & S.S. Umare, Engineering Chemistry, S. Chand & Company.
4.	R. Mukhopadhyay, Advanced Engineering Chemistry, New Age International.
5.	Anastas & Warner, Green Chemistry: Theory and Practice, Oxford University Press.

Course Code		L	T	P	C	IA	EA	TM
Course Name	**BASIC ELECTRICAL ENGINEERING**	2	1	0	3	40	60	100
Course Category	ENGINEERING SCIENCE COURSE	Syllabus Revision				V.1.0		
Pre-requisite								

Course Objectives:

The course should enable the students -

1. This course equips students to have basic knowledge and understanding in solving algebraic, transcendental equation numerically.
2. To make the student knowledgeable in the area of matrix theory so that he/she will be familiar in MATLAB applications.
3. To familiarize the student with functions of several variables. This is needed in many branches of Engineering.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Explain the basic electrical quantities and laws.	**K2**
CO2	Explain construction, types and applications of electrical machines.	**K2**
CO3	Study the working principles of power converters.	**K2**
CO4	Show the tariff or a given load and energy consumption.	**K2**
CO5	Introduce the components of low voltage electrical installations and its applications.	**K3**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	S	S	L	L	M	M	M	-	S	M	-	S	-	-	-
CO2	S	S	M	M	M	S	M	L	S	M	L	M	-	-	-
CO3	S	S	M	M	S	M	M	-	M	M	-	M	-	-	-
CO4	S	S	S	S	S	M	M	M	M	M	L	M	-	-	-
CO5	S	S	M	S	M	M	L	L	S	M	L	M	-	-	-

UNIT-I	DC CIRCUITS	9 Hours

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

UNIT-II	**AC CIRCUITS**	**9 Hours**
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.		
UNIT-III	**TRANSFORMERS**	**9 Hours**
Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.		
UNIT-IV	**ELECTRICAL MACHINES**	**9 Hours**
Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque- speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.		
UNIT-V	**POWER CONVERTERS AND ELECTRICAL INSTALLATIONS**	**9 Hours**
DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.		
	Total Hours	**45 Hours**

Text Book(s)	
1.	D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2.	D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
Reference Book(s)	
1.	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2.	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3.	V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Code		**L**	**T**	**P**	**C**	**IA**	**EA**	**TM**
Course Name	**PROGRAMMING FOR PROBLEM SOLVING**	3	0	0	2	40	60	100
Course Category	ENGINEERING SCIENCE COURSE	**Syllabus Revision**					V.1.0	
Pre-requisite								

Course Objectives:

The course should enable the students -

1. Exposed to the syntax of C.
2. Familiar with programming in C.
3. To learn arrays, strings, functions, pointers, structures and unions in C.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	**Description**	**Highest Bloom's Taxonomy**
CO1	Develop algorithms for solving simple mathematical and engineering problems and examine the suitability of appropriate repetition and or selection structures for given problems.	**K3**
CO2	Solve matrix problems, merging, searching, sorting and string Manipulation problems using iteration, modularization or recursion as applicable.	**K3**
CO3	Organize files to perform text operations like editing, pattern Searching using structures.	**K3**
CO4	Implement the algorithms for matrix problems, merging, searching, sorting, and string manipulation and file problems and debug and test using any procedural programming language.	**K3**

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	S	S	S	S	S	M	L	L	M	M	-	M	-	-	-
CO2	S	S	S	S	S	M	L	L	M	M	-	M	-	-	-
CO3	S	S	M	M	S	M	L	L	M	M	-	M	-	-	-
CO4	S	S	S	S	S	M	L	L	S	S	-	S	-	-	-

UNIT-I	**Module - I**	**9 Hours**

Introduction to components of computer system-Generation of programming languages-Types of

Computers-Organization of Computers-Types of memory, Number systems- Idea of Algorithm-Pseudo code- Flow Chart with examples.		
UNIT-II	**Module - II**	**9 Hours**
Introduction to C-Character set, Constants, Variables, Data Types-Operators – Arithmetic expressions and precedence-Decision Making statement - Looping statements.		
UNIT-III	**Module - III**	**9 Hours**
Arrays and its types-Functions –Parameter passing in functions-call by value- call by reference Passing array to functions-Recursive function.		
UNIT-IV	**Module - IV**	**9 Hours**
Structures and array of structures –Union, Basic searching –Linear and Binary, Basic sorting, String operations.		
UNIT-V	**Module - V**	**9 Hours**
Introduction to Pointer, Pointer arithmetic-notion of linked list (no implementation) - File handling.		
	Total Hours	**45 Hours**

Text Book(s)

1.	Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2.	Balagurusamy. E, "Programming in ANSI C", Tata McGraw Hill, Third edition, 2006.
3.	Fundamentals of Computing and Programming- V.RameshBabu, R.Samyuktha, M.Muniratham by VRB Publishers 2012 edition.

Reference Book(s)

1.	Let Us 'C' – Yashawant Kanetkar, (Unit 2 to 5), BPB publications, 10th Edition, 2010.
2.	Ashok N Kamthane, "Computer Programming", Pearson education, Second Impression.
3.	Kernighan Venugopal.K and Kavichithra.C, "Computer Programming", New Age International Publishers, First Edition, 2007.
4.	B.W and Ritchie,D.M , The C programming language: second edition, Pearson education,2006.

Course Code		L	T	P	C	IA	EA	TM
Course Name	ENGINEERING GRAPHICS AND DESIGN [THEORY & PRACTICAL]	2	0	1	3	40	60	100
Course Category	ENGINEERING SCIENCE COURSE	Syllabus Revision				V.1.0		
Pre-requisite								

Course Objectives:

The course should enable the students

1. To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2. To expose them to existing national standards related to technical drawings.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Draw orthographic projections of lines, planes and solids.	K3
CO2	Draw projections of solids including cylinder, prism andpyramid.	K3
CO3	Draw section of solids including cylinder, prisms andpyramids.	K3
CO4	Draw the development of surfaces including cylinder, Pyramid and prism.	K4
CO5	Draw projection of lines, planes, solids, orthographic, projection, Isometric projection, and section of solids including cylinder, cone, prism, pyramid and building drawing using AutoCAD.	K6

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-
CO2	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-
CO3	S	S	S	S	S	M	M	-	M	L	M	L	-	-	-
CO4	S	S	S	S	S	M	M	-	M	M	M	L	-	-	-
CO5	S	S	S	S	S	L	M	-	M	L	M	L	-	-	-

Traditional Engineering Graphics:
Principles of engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing;. Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.
Computer Graphics:
Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling; Introduction to Building Information Modeling (BIM). **(Except the basic essential concepts, most of the teaching part can happen Concurrently in the laboratory)**
Module 1: Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloids, Hypocycloid and In volute; Scales – Plain, Diagonal and Vernier Scales
Module 2: Orthographic Projections covering**,** Principles of Orthographic Projections- Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes
Module 3: Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.
Module 4:Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone - Auxiliary Views; Development of surfaces of Right Regular Solids, Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)
Module 5: Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.
Module 6: Overview of Computer Graphics covering, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids
Module 7: Customization & CAD Drawing consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles
Module 8: Annotations, layering & other functions covering applying dimensions to objects,

applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two- dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling	
Module 9: Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).	
Total Hours	**45 Hours**

Text Book(s)

1.	Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
2.	Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
3.	Agrawal B. & Agrawal C. M. (2012), Engineering Graphics: TMH Publication.
4.	Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, SciTech Publishers.

Course Code		L	T	P	C	IA	EA	TM
Course Name	**BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB**	0	0	2	2	40	60	100
Course Category	ENGINEERING SCIENCE COURSE	Syllabus Revision					V.1.0	
Pre-requisite								

Course Objectives:

The course should enable the students

1. This course equips students to have basic knowledge and understanding in solving algebraic, transcendental equation numerically.
2. To make the student knowledge able in the area of matrix theory so that he /she will be familiar in Matlab applications.
3. To familiarize the student with functions of several variables. This is needed in many branches of engineering.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Obtain load characteristics of Single Phase Induction Motor, Three Phase Induction Motor, Single Phase Transformer and Three Phase Alternator.	K3
CO2	Obtain Speed Control of DC Motor, Three Phase Induction Motor (Pole Changing Method).	K3
CO3	To demonstrate the working of Multi meter, CRO and LCR Meter and Measurement of Voltage, Current and Power.	K3
CO4	To Verify experimentally Kirchhoff's Law and Thevenin's Theorem.	K3
CO5	Obtain the B - H Curve of a Magnetic Material.	K4

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	S	M	M	M	M	M	-	-	S	M	-	L	-	-	-
CO2	S	S	M	M	S	M	L	-	S	S	-	M	-	-	-
CO3	S	S	M	M	S	M	L	-	S	M	L	M	-	-	-

CO4	S	S	S	S	M	M	L	L	M	M	-	S	-	-	-
CO5	M	M	M	S	M	M	L	-	M	M	-	M	-	-	-

List of Experiments

1. Study of Electric Motors (AC & DC Motors)
2. Load Test on Single Phase Induction Motor
3. Load Test on Three Phase Induction Motor
4. Load Test on Single Phase Transformer
5. Load Test on Three Phase Alternator
6. Speed Control of DC Motor
7. Speed Control of Three Phase Induction Motor (Pole Changing Method)
8. Study of Multi meter, CRO and LCR Meter
9. Measurement of Voltage, Current and Power.
10. Verification of Kirchoff's Law
11. Verification of Thevenin's Theorem
12. B·H Curve of a Magnetic Material
13. Rectifier Circuit Analysis (AC – DC)
14. Inverter Circuit Analysis (DC – AC)
15. Chopper Circuit Analysis (DC – DC)
16. Series and Parallel RLC Circuit Analysis

Total Hours	**45 Hours**

Course Code		L	T	P	C	IA	EA	TM
Course Name	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	0	0	2	2	40	60	100
Course Category	ENGINEERING SCIENCE COURSE	Syllabus Revision					V.1.0	
Pre-requisite								

Course Objectives:

The course should enable the students

1. To get a clear understanding of Programming Concepts of 'C' language.

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Develop algorithms for solving simple mathematical and engineering problems and examine the suitability of appropriate repetition and/or selection structures forgiven problems.	K3
CO2	Solve matrix problems, merging, searching, sorting and string Manipulation problems using iteration, modularization or recursion as applicable.	K3
CO3	Organize files to perform text operations like editing, pattern searching using structures	K3
CO4	Implement the algorithms for matrix problems, merging, searching, sorting, and string manipulation and file problems and debug and test using any procedural programming language.	K3

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	S	S	S	S	S	M	L	L	M	M	-	M	-	-	-
CO2	S	S	S	S	S	M	L	L	M	M	-	M	-	-	-
CO3	S	S	M	M	S	M	L	L	M	M	-	M	-	-	-
CO4	S	S	S	S	S	M	L	L	S	S	-	S	-	-	-

	LIST OF EXPERIMENTS	
	1. Basic programs in data types. 2. Evaluate Expressions using library Function. a. πr^2 b. (A+B+(2C/3A)+A2+2B) c. √S(S-A) (S-B) (S-C) d. LOG ($x^3+y^3+z^3$) 3. Problems in Decision making statements. i. Find the Biggest among 3 numbers. ii. Find Even or odd iii. Arithmetic operations using Switch - Case Statements. 4. Problems in looping statements. i. Find the Sum of digits using (i) For loop (ii) While loop ii. Generate the Fibonacci series iii. Check whether the number is prime or not. 5. Find the Linear Search. 6. General sorting. 7. Matrix Manipulation-Addition, Subtraction and Multiplication. 8. String operations-string copy, string reverse, string concatenate. 9. Swapping of numbers using call by value, call by reference. 10. Find factorial using recursive functions. 11. Numerical methods-Quadratic Equation. 12. Display the student information & marks using Structure & Unions. 13. Demonstrate array of structures. 14. Pointer Arithmetic and Array access using Pointers. 15. Basic File Operations	
		45 Hours

Course Code		L	T	P	C	IA	EA	TM
Course Name	SOFT SKILLS	2	0	0	1	40	60	100
Course Category	VOCATION AND SKILL ENHANCEMENT COURSE	Syllabus Revision					V.1.0	
Pre-requisite	Knowledge of English Language							

Course Objectives:

The course should enable the students -

1. To develop communication skills and writing skills through individual / group activities.
2. To improve the quality of conversations in day to day life
3. To understand the thumb rules in English grammar
4. To improve vocabulary in English
5. To develop professional and positive attitudes

Course Outcomes:

On completion of the course, the student will be able to

Course Outcomes	Description	Highest Bloom's Taxonomy
CO1	Have good command over the language	K3
CO2	Write reports and technical documents effectively	K3
CO3	Understand the thumb rules in English Grammar	K3
CO4	Relate, choose and determine the usage of right vocabulary.	K4
CO5	Participate in group discussion, interviews and deliver presentations	K4

Correlation between Course Outcomes (COs) and Program Outcomes (POs):

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	M	-	M	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-
CO3	-	-	-	-	-	-	-	M	-	M	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-
CO5	-	-	-	-	-	-	-	M	-	M	M	-	-	-	-

1	Importance of Developing Communication Skills
2	Common Errors in Spoken English
3	Error Correction Exercises
4	Thumb Rules in English Grammar

5	Grammar Exercises Related to Nouns, Verbs & Articles
6	Reading Comprehension – Sentences, Paragraphs & Passages
7	Effective Communication Skills – Good Vocabulary & Basic Grammar
8	Subject Verb Agreement
9	Vocabulary – Synonyms & Antonyms
10	Writing Essays, Reports etc
11	Conversations in Day to Day Life
12	Story Development from Hints
13	Speaking Exercises (Each student to speak for 3 minutes)
14	Spelling Exercise & Punctuation
15	Pronunciation
Total Hours	**45 Hours**

Text Book(s)

1.	Dr. NDV. Prasada Rao, "High School English Grammar and Composition", Wren and Martin, S. Chand Publishers, 2017 Edition.
2.	S. C. Gupta, "English Grammar and Composition", Very Useful for All Competitive Examinations, Arihant Publications, 2020 Edition.
3.	Howard Jackson, "Grammar and Vocabulary: A Resource Book for Students", Routledge Publications, 2002 Edition.